

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in the application:

Listing of Claims:

1-24. (cancelled)

25. (Previously presented) The method of claim 29, wherein the surface comprises a two dimensional surface.

26-28. (Cancelled)

29. (Previously Presented) A method comprising:

obtaining a three dimensional model of a three dimensional environment, the three dimensional model generated from range sensor information representing a height field for the three dimensional environment;

identifying in real time a region in motion with respect to a background image in real-time video imagery information from at least one image sensor having associated position and orientation information with respect to the three dimensional model, the background image comprising a single distribution background dynamically modeled from a time average of the real-time video imagery information;

placing a surface that corresponds to the moving region in the three dimensional model, wherein placing the surface comprises casting a ray from an optical center, corresponding to the real-time video imagery information, to a bottom point of the moving region in an image plane in the three dimensional model, and determining a position, an orientation and a size of the surface based on the ray, a ground plane in the three dimensional model, and the moving region;

projecting the real-time video imagery information onto the three dimensional model, including the surface, based on the position and orientation information; and

visualizing the three dimensional model with the projected real-time video imagery;

wherein identifying a region in motion in real time comprises subtracting the background image from the real-time video imagery information, identifying a foreground object in the subtracted real-time video imagery information, validating the foreground object by correlation matching between identified objects in neighboring image frames, and outputting the validated foreground object.

30. (Previously presented) The method of claim 29, further comprising tracking the position and orientation information of the at least one image sensor in the environment with respect to the three dimensional model in real-time.

31. (Previously presented) The method of claim 30, wherein obtaining a three dimensional model of a three dimensional environment comprises generating the three dimensional model of the three dimensional environment.

32. (Cancelled)

33. (Previously presented) The system of claim 37, wherein the surface comprises a two dimensional surface.

34-36. (Cancelled)

37. (Previously Presented) An augmented virtual environment system comprising:
an object detection and tracking component that identifies in real time a region in motion with respect to a background image in real-time video imagery information from at least one image sensor having associated position and orientation information with respect to a three dimensional model of a three dimensional environment, the three dimensional model generated from range sensor information representing a height field for the three dimensional environment, the background image comprising a single distribution background dynamically modeled from a time average of the real-time video imagery information, and places a surface that corresponds to the moving region with respect to the three dimensional model, wherein the object detection and

tracking component places the surface by performing operations comprising casting a ray from an optical center, corresponding to the real-time video imagery information, to a bottom point of the moving region in an image plane in the three dimensional model, and determining a position, an orientation and a size of the surface based on the ray, a ground plane in the three dimensional model, and the moving region;

a dynamic fusion imagery projection component that projects the real-time video imagery information onto the three dimensional model, including the surface, based on the position and orientation information; and

a visualization sub-system that visualizes the three dimensional model with the projected real-time video imagery;

wherein the object detection and tracking component identifies the moving region by performing operations comprising subtracting the background image from the real-time video imagery information, identifying a foreground object in the subtracted real-time video imagery information, validating the foreground object by correlation matching between identified objects in neighboring image frames, and outputting the validated foreground object.

38. (Previously presented) The system of claim 37, further comprising a tracking sensor system that integrates visual input, global navigational satellite system receiver input, and inertial orientation sensor input to obtain the position and the orientation information associated with the at least one image sensor in real time in conjunction with the real-time video imagery.

39. (Previously presented) The system of claim 38, further comprising a model construction component that generates the three dimensional model of the three dimensional environment.

40-49. (Cancelled)

41. (Previously Presented) The method of claim 29, wherein identifying a foreground object comprises identifying the foreground object in the subtracted real-time video imagery information using a histogram-based threshold and a noise filter.

42. (Previously Presented) The method of claim 41, wherein identifying a region in motion in real time further comprises estimating the background image by modeling the background image as a temporal pixel average of five recent image frames in the real-time video imagery information.

43. (Previously Presented) The system of claim 37, wherein identifying a foreground object comprises identifying the foreground object in the subtracted real-time video imagery information using a histogram-based threshold and a noise filter.

44. (Previously Presented) The system of claim 43, wherein identifying a region in motion in real time further comprises estimating the background image by modeling the background image as a temporal pixel average of five recent image frames in the real-time video imagery information.

45. (Currently Amended) A machine-readable storage device ~~medium~~ embodying information indicative of instructions for causing one or more machines to perform operations comprising:

obtaining a three dimensional model of a three dimensional environment, the three dimensional model generated from range sensor information representing a height field for the three dimensional environment;

identifying in real time a region in motion with respect to a background image in real-time video imagery information from at least one image sensor having associated position and orientation information with respect to the three dimensional model, the background image comprising a single distribution background dynamically modeled from a time average of the real-time video imagery information;

placing a surface that corresponds to the moving region in the three dimensional model, wherein placing the surface comprises casting a ray from an optical center, corresponding to the real-time video imagery information, to a bottom point of the moving region in an image plane in

the three dimensional model, and determining a position, an orientation and a size of the surface based on the ray, a ground plane in the three dimensional model, and the moving region;

projecting the real-time video imagery information onto the three dimensional model, including the surface, based on the position and orientation information; and

visualizing the three dimensional model with the projected real-time video imagery;

wherein identifying a region in motion in real time comprises subtracting the background image from the real-time video imagery information, identifying a foreground object in the subtracted real-time video imagery information, validating the foreground object by correlation matching between identified objects in neighboring image frames, and outputting the validated foreground object.

46. (Currently Amended) The machine-readable storage device medium of claim 45, wherein the surface comprises a two dimensional surface.

47. (Currently Amended) The machine-readable storage device medium of claim 45, further comprising tracking the position and orientation information of the at least one image sensor in the environment with respect to the three dimensional model in real-time.

48. (Currently Amended) The machine-readable storage device medium of claim 47, wherein obtaining a three dimensional model of a three dimensional environment comprises generating the three dimensional model of the three dimensional environment.

49. (Currently Amended) The machine-readable storage device medium of claim 45, wherein identifying a foreground object comprises identifying the foreground object in the subtracted real-time video imagery information using a histogram-based threshold and a noise filter.

50. (Currently Amended) The machine-readable storage device medium of claim 45, wherein identifying a region in motion in real time further comprises estimating the background

Applicant : Ulrich Neumann et al.
Serial No. : 10/676,377
Filed : September 30, 2003
Page : 7 of 15

Attorney's Docket No.: 06666-156001 / #3345A

image by modeling the background image as a temporal pixel average of five recent image frames in the real-time video imagery information.